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Tesi di Specializzazione

COMPUTED TOMOGRAPHY IN POLYTRAUMA: EXPERIENCE IN A RADIOLOGY EMERGENCY FIRST LEVEL

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ABSTRACT

Purpose

The purpose of this study is to demonstrate how Computed Tomography (CT) is essential in polytrauma patients who access to an Emergency Radiology first level, reducing time to diagnosis and treatment of injuries that are often life-threatening.

Materials and Methods

Were retrospectively analyzed all CT examinations with or without intravenous infusion of iodinated contrast medium performed on patients affered from the First Aid between October 2010 and February 2012 (17 months). The studies were conducted on multislice CT (16 and 64 MSCT) and sent to a console that allowed to view the axial images and process the volume studied obtaining multiplanar (MPR) and tridimensional reconstruction (VR: Volum Rendering).
Have been performed a total of 10.106 CT examinations, in particular 3.483 of these (approximately 34.5%) for trauma and 590 of the latter (about 5.8%) in patients with a diagnosis of "Polytrauma” at First Aid. For each patient was analyzed the district of the body concerned and the type of injury.

Results

The polytrauma patients were 124 (3 from the Pediatric Emergency Department) which 96 male and 28 female. The age of patients ranged from 18 months to 87 years, with more than 50% under 40 years.
The lung was the organ most affected by traumatic pathology, followed by the head and the spleen. Our results are consistent with the literature data except the trauma of the spine; particularly we found a greater involvement of dorsal tract versus the cervical spine fractures in literature.

Conclusion

The MSCT plays an important role in the management of severely injured patients. Its technical characteristics enable an effective diagnosis and a focused therapy of potentially life-threatening injuries at an early stage of the emergency room treatment. CT is more complete and also more consistent than conventional radiology and it has the great advantage of allowing rapid examination of the head, vertebral column, chest, abdomen and pelvis during one single radiological examination.

INTRODUCTION

The term "*Polytrauma*" is generally used to describe (mainly) blunt trauma patients whose injuries involve multiple body regions or cavities, compromise the patient's physiology and potentially cause dysfunction of uninjured organs. These patients are at risk of higher morbidity and mortality than the summation of expected morbidity and mortality of their individual injuries. Polytrauma patients are very seriously injured but can be potentially saved with efficient triage and focused trauma specialist care in dedicated institutions.(1)

Be deemed to be all polytrauma patients who have undergone a high-energy trauma even without immediate evidence of injury.

The traumatic injury are due to road accidents, incident at work burns, gunshot wounds and burns white. The criteria for the definition greater dynamic and/or high energy impact, that identify patients at risk of injury, are the following:

a) Pedestrian thrown or run over at speeds > 8 km/h.

b) Motorcycle crash > 30 km/h or rider thrown from vehicle.

c) High-speed car crash (> 50 km / h), major auto deformity, intrusion into passenger compartment, thrown passenger.

d) Death of a victim in the same passenger compartment of a vehicle.

e) Extrication time >20 minutes.

f) Fall > 3 m.

g) Roll over

Co-Morbid factors: pregnancy, age <5 or > 65, history or cardiac or respiratory disease, insulin-dependent diabetes, cirrhosis, morbid obesity, immunosuppressed patients (2, 3). On a worldwide basis the trauma is responsible for 9% of deaths and is the fourth cause of death after cardiovascular diseases, infections and tumors. The overall mortality rate from trauma in Western Europe of 47.6 persons to 100.000/year and is the leading cause of death in young people (under 45 years). The socio-economic impact of trauma and its sequellae are tremendeous because the incidence is increasing and affecting the most productive age group. (4)

Traditionally, mortality in polytrauma is divided into 3 categories (trimodal curve) according to the time that elapses after the traumatic event. The first peak refers to the *immediate deaths* within the first few minutes or during transport to the hospital (50% of total mortality). The second, *early deaths*, occurs within the first hour, from 30 min to 4 hours (30% of global mortality), these patients mostly die for uncontrollable bleeding, brain injury with intracranial hypertension, acute respiratory

failure. The third peak, *later deaths*, it develops in the days and weeks following the trauma and is due to septic complications and multiorgan compromise.
The prevention of the first two peaks of mortality depends on the quality and organization of trauma care system, ie the assistance during the *"golden hour"* given by an integrated sequence of steps including: immediate treatment, primary transport, diagnosis and treatment in the ED (Emergency Department), eventually secondary transport and final treatment. (5)
The world guidelines are developed by the American College of Surgeons that says "prioritization of treatment in a polytraumatized patients is the result of: quick overview of the patient, Primary Assessment, Secondary Assessment, appropriate use of diagnostic techniques and resuscitation." The specific management criteria outlined by an algorithm based upon the principle of the "golden hour in shock," primary diagnostic procedures must be highly effective, focused and restricted to essential questions. The primary clinical and radiological survey completed should be within thirty minutes after admission in the emergency room. (6)
In Europe there are numerous diagnostic and therapeutic management of polytrauma, which are close to international guidelines.
The polytrauma patients undergo:
1) Primary Assessment: to identify and treat the injuries that are immediately life-threatening through a clinical approach encoded (A, B, C, D, E[1]), integrated by therapeutic and diagnostic tools. The imaging relies on the use of X-ray chest and ECO-FAST (Focused Assessment with Sonography for Trauma); in selected cases (hemodynamic stability, clinically suspected pelvic trauma, dislocation of the hip) is performed X-ray pelvis; in some centers is also done lateral cervical spine X-ray.
2) Secondary Assessment: to identify the major injuries through the examination rapid and strictly sequential, the collection of anamnestic data and information on the dynamics of the event, and the rapid access to MSCT room (patient hemodynamically stable) for completing the balance of injury and define the clinical and therapeutic priorities.
3) Quick and priority access to the operating room or hub centers (centers of reference/excellence): intended for patients hemodynamically unstable and not stabilizable.
4) Identification of so-called "hidden lesions", through a comprehensive reassessment of the trauma patient spent 24-72 hours after its take-over in order to diagnostic studies to address the areas of the body not examined during the Secondary Assessment. (7,8,9,10)

[1] A (airway) - B (breathing) - C (circulation) – D (disability) – E (exposure)

Role of Computed Tomography

Computed Tomography is extremely important for the study of hemodynamically stable patients. No patient should be submitted until have completed the Primary Assessment and initiated the necessary clinical-instrumental monitoring that continue during the examination. If the patient's clinical condition get worse it must be quickly stopped. MSCT provides qualitative and quantitative information and gives an anatomical description of the lesions. The acquisition time is considerably reduced and allows the assessment of large volume of study using layer thicknesses up 0.4 / 0.6 mm; the use of the contrast medium, finally, allows a functional assessment of the districts investigated and a careful study of the vascular structures including heart.

Head and Neck trauma

The trauma of the head affecting the brain or the skull. In the first case we can distinguish focal lesions (extradural and subdural hematomas, cerebral contusions, subarachnoid and intraventricular hemorrhage, vascular lacerations) and diffuse lesions (diffuse axonal injury, cerebral edema with o without herniations and pneumoencefalo); the most important disease of the skull is represented by fractures which are divided into fractures of the cranium (anterior, middle and posterior cranial base and vault) and the facial (middle third and lower third).

The neck injuries affecting the soft tissues, vascular structures, the airways and digestive tract.

Thoracic Abdominal Pelvic and External Genitals trauma

The trauma of these districts is classically divided into open or closed and may be of interest to the container (ribs, sternum, clavicle, scapula and thoracic/abdominal muscle structures), the content (lung, pleura, mediastinum, diaphragm, abdominal and pelvic organs, vascular structures) and the external genitalia organs.

Spinal trauma

The trauma may affects the cervical, thoracic and lumbar tract separately or in combination; it is important to evaluate the stability of the spine affected by injuries because a possible instability can produce abnormal movement between the vertebrae such to determine a bone marrow compromise further with the result of aggravation of neurologic injury reported at the level of trauma. There are three longitudinal columns of stability (anterior, middle and posterior); if the traumatic event involving more than one column, the fracture is considered unstable.

The involvement of the spinal cord divided into mielic or amielic.

Pelvis and Acetabulum trauma

Fractures of the pelvis are divided into stable and unstable.

The stable includes fractures that do not disrupt the pelvic ring (avulsion of the anterior superior iliac spine, anterior inferior iliac spine, ischial tuberosity; low transverse fractures of the sacrum and coccyx; fractures of the iliac crest) or disrupt it in only the front side but they are composed (fractures of the ilium-ischium-pubic branches of the elderly).

Unstable fractures are those involving the ischio-pubic branches on one side and are associated with disruption of the sacroiliac joint, or fracture through the sacral ala or ilium ipsilateral and those involving both obturator rings or ischiopubic branches one side associated with fracture near the contralateral sacroiliac joint or disruptions of the same; fall in the unstable lesions even dislocation of the pelvis which can be unilateral (pubic and sacroiliac joint diastasis) or bilateral (symphysis pubic and both sacroiliac joints diastasis). (note bibliog). In fractures of the pelvis by convention we included also the acetabulum.

The injuries of the extremity include fractures, dislocations and vascular lesions.

MATERIALS AND METHODS

Were analyzed retrospectively all CT examinations with or without intravenous infusion of iodinated contrast medium (including: Head, Chest and Abdomen, Cervical, Dorsal and Lombosacral Spine, Pelvis and bone segments CT) performed at the Early Rescue of the Versilia Hospital in a period between October 2010 and February 2012 (17 months).

Imaging technique and analysis

All CT studies were performed on MSCT scanner (Light Speed 64s and Bright Speed 16s- GE Healthcare), according toa dedicated multiphase protocols, including pre and post contrastographic acquisitions.

Patients received approximately 2mL/Kg of intravenous iodinated contrast agent at a flow rate of 3-5 mL/sec. Post-contrastographic acquisitions were obtained on arterial, venous and sometimes late phases. In selected patients, computed assisted bolus tracking software was applied to determinate the optimal scan delay.

In selected patients (such e.g. in suspicion of leakage of the bladder wall) additional acquisition were performed (administered transcatheter iodinated contrast).

Technical parameters of pre and post contrastographic scans are reported on table 1.

In some cases the Radiologist did modify the scan protocol, according to the patient's age, the clinical suspect and the findings appreciable on baseline examination.

All CT studies were subsequently evaluated by means of dedicated console (Advantage Workstation GE Healthcare) in order to visualize axial images on different planes, and allow multiplanar reconstructions (MPR) on the coronal and sagittal planes, as well as Volume Rendering (VR) of the acquired volume.

RESULTS

Among all the 10106 CT examinations performed at the Early Rescue of our Hospital, 3483 (34.5 %) were done because of a clinical suspect of trauma.
Among those examinations, 590 (5.8%) were performed in order to assess the presence of lesions in patients classified at the Triage as polytrauma patients.
Patients with polytraumatic lesions resulted to be 124 (3 were pediatric patients), of whom 96 were males and 28 females. Three patients were unknown, with an age ranging between 18 months and 87 years (more than 50% of patients were under 40 y.o).
For each patient, we did evaluate the body regions interested by traumatic lesions and the type of detected lesion.
In the 25.8% of cases, the patients did show a lesion in a single body region; in the 65.3% of cases, the body regions interested by traumatic lesions were ≥ a 2 and in a 4.8% of cases, CT did not found any traumatic injury.
On the basis of different interested body regions, both on adults and pediatric patients identified lesions were the following.
In the head and neck region, 30 patients did show the fracture of the middle portion of the maxillo facial region, 27 did show subarachnoid hemorrage, 24 did show intraparenchimal cerebral haemorrage, 13 did show subdural hematoma, 13 did show the fracture of the cranic vault, 11 the fracture of the middle cranic base, 10 the fracture of the anterior cranic base, 9 intraventricular haemorrage, 9 cerebral oedema, 7 the fracture of the inferior portion of the maxillo facial region, 5 pneumoencephalus, 4 the fracture of the posterior cranial base, 3 herniation, 2 extradural hematoma, 2 lesion of the respiratory tract, 1 patient did show the laceration of the soft tissue of the neck region, 1 patient had a vascular lesion of the verterbral artery. Foreign bodies were 2 (Graph 1 - 2).
The following lesions were found in the thorax: 63 ribs fractures, 57 pulmonary contusions/haemorrage, 35 pneumothorax, 23 pleural effusion, 16 subcutaneous emphisema, 15 breastbones fractures, 10 clavicola fractures, 10 scapola fractures, 7 pneumomediastinum, 6 pneumocele, 5 haemomediastinum, 3 mediastinum delocalization, 3 diaphragmatic lesions, 2 muscular lesions, 1 aortic lesion (Graph 3).
In the abdomen and pelvis, the following lesions were appreciable: 37 haemoperitoneum, 21 abdominal viscera contusion (9 livers, 4 spleens, 4 kidneys, 3 adrenals, 1 pancreas), 11 lacerations of abdominal parenchymas (6 livers, 4 spleens, 1 bladder), 8 spleen ruptures, 6 abdominal wall lesions, 4 active haemorrages (3 at the splenic hilum and 1 at the liver hilum), 2 external genital

lesions, 1 retroperitoneal hematoma, 1 periportal tracking, 1 spleen hematoma, 1 destruction of the spleen, 1bladder lesion and 1 case of great omentum laceration.

Spinal lesions were: 20 stable fractures of the cervical spine, 23 stable fractures of the dorsal spine, 19 stable fractures of the lumbar sacral spine, 2 unstable fractures of the cervical spine, 6 unstable fractures of the dorsal spine, 3 unstable fractures of the lumbar sacral spine; in 5 cases the spinal cord was interested (in 4 cases in the dorsal tract and in 1 case at the lumbar tract), 1 endocanalar foreign body (metallic fragment from fire arm in the dorsal tract).

Sacroiliac bones injuries were: stable fracture in 9 cases, unstable fracture in 8 cases, acetabolar fracture in 6 cases.

Limbs lesions were: 11 femur fractures, 4 humerus fractures, 3 tibia fractures, 3 foot fractures, 1 radius fracture, 1 ulnar fracture, 1 fibula fracture, 3 femur luxations, 2 patella luxations, 2 tarso-metatarsal luxations, 1 tibio fibula luxation and scapulo humeral luxation, 1 vascular lesion.

In 2 patients, limbs injuries were higlighted occasionally in the scout acquisition; in 3 cases, the CT study was dedicated to a specific scheletric region, while in the other cases, regions were included in the volume of acquisition.

In one single patient, a dedicated angio-CT study of the inferior limbs vessels was performed.

The thorax resulted to be the most involved body region in traumatic events, and particularly, the lung with a vast majority of haemorrage/contusion phenomena (57 patients) and the thorax wall, with ribs fractures (63 patients).

The second most frequent injury resulted to involve the cranium, because of subarachnoid hemorrage (27 patients) as parenchymal finding, and because of fractures of the middle portion of the maxillo facial (30 patients).

In the abdomen, the spleen resulted to be the most involved parenchyma in traumatic injuries (16 patients), while haemoperitoneum (37 patients) was present in the vast majority of cases, often associated to parenchymal alterations or omentum laceration.

Dorsal spine resulted to be the most frequently involved tract of the spine (29 patients), with a majority of stable fracture.

No significant difference was registered among sacroiliac stable and unstable fractures.

The most interested peripheral scheletric segment resulted to be femur (10 patients; 1 patient did show bilateral fractures).

One pediatric patient did show traumatic injuries of the skull, of the thorax, and the abdomen, while one did show injurie of the skull, thorax, and superior limb, and the third patient did show injuries of the thorax.

DISCUSSION AND CONCLUSION

The Versilia Hospital has an Emergency Departement (first level) offering: observation and short hospital stay, intensive care, cardiac intensive care unit, chemical and microbiological laboratory, diagnostic imaging and blood transfusion center ensured in 24 hours.
The our Hospital is part of a regional network organized according to the "Hub and Spoke" which provides a reference center (hub) to which the peripheral structures (Spoke) send the complex patients that can't be treated at the peripheral level (11,12).
These structures can be linked telematically, or by sending the radiological documentation on CD.
These patients are always transferred to the ED II level which ensure most qualified functions including: neurosurgery, heart surgery, neonatal intensive care, thoracic surgery, vascular surgery.
The Radiology Unit of Versilia Hospital has a teleradiology service (up to April 2011, with the UO Neuroradiology/Neurosurgery Hospital of Pisa, and then with Livorno) that uses a computer system implemented by the Data Processing Center between the two structures in collaboration with Siemens Healthcare. The system transmits images up to a maximum of 150 (with higt quality) through a connection VPN (Virtual Private Network) and the examination is evaluated on workstations with the same PACS (Picture Archiving and Communication System).
Patients who need heart surgery or angiography are usually sent to the hospitals of MassaCarrara or alternatively of Pisa.
The referral hospital for pediatric disease is the Mayer of Florence.
The complex orthopedic injuries are sent to the Orthopaedic Trauma Centre of Florence.
The management of the polytrauma patient at Versilia Hospital is through a standardized diagnostic instrument which uses a protocol developed between the Departments of Emergency, Intensive Care and Diagnostic Imaging, in order to ensure: homogeneous behavior and agreement between different health units, effective treatment and complies with current international guidelines (ATLS 1997/2002) and optimization of intervention times in the diagnostic-instrumental (Attachment1).
CT investigations are performed, in haemodynamically stable patients during the Second Evaluation, according to a standardized screening survey. Clinical evaluation and stabilization of the haemodynamic and cardiopulmonary parameters are performed parallel with CT. In fact, while the patient is positioned on the CT-table, consciousness, respiratory function and circulation are evaluated and a primary clinical survey of the injury pattern is performed according to the ATLS principles.
The technical characteristics of CT enable an effective diagnosis and a focused therapy of potentially life-threatening injuries at an early stage of the emergency room treatment. It's more

complete and also more consistent than conventional radiology and it has the great advantage of allowing rapid examination of the head, vertebral column, chest, abdomen and pelvis during one single examination by a relevant reduction of the scanning time due to an increased speed of image acquisition. Larger volumes can be examined with a high resolution (slice thickness up to 0,4/0,6 mm) and there is the ability to obtain multiplanar and tridimensional reconstructions and immediate on and off line interpretation of the images at separate workstations. Also the use of iodinated contrast medium allows a correct study of the arterial vascular structures (compared to the past even as heart disease) and venous, as well as the parenchyma, bone and muscle structures.

All that contribute to the introduction of the MSCT in the primary survey of polytrauma victims and, thanks to the widespread distribution of equipment on the territory, it becomes the Gold Standard for the detection of lesions in polytrauma patients.(13,14)

Once the examination is completed, the further strategy will depend upon the haemodynamic situation of the patient and the specific findings of the CT scan.

Some lesions are amenable to immediate surgical treatment with the patient still on the CT table, e.g. the insertion of a thoracic drain for the management of a pneumo and/or haematothorax. It is decided whether the patient is transferred directly to the operating theatre or the intensive care department or whether further diagnostic procedures are scheduled, e.g. conventional radiological imaging of extremity fractures or angiography. Whereas some fractures of the limbs are higlighted occasionally in the scout acquisition, further diagnosis of those injuries in most cases still relies on conventional radiographs.

The patients remain in the CT room for a mean time of 27 minutes (range:15-45 min).

In agreement with the literature data in our study, CT identified traumatic lesions that most often affect the patients.

In the head region, MSCT allows to detect lesions of the cerebrum, the skull and the skeletal face; this is especially important because 70% of all fatalities within 24 hours after trauma are attributable to severe brain damage .

CT advantages for evaluation of the head-injured patient include its sensitivity for demonstrating mass effect, ventricular size and configuration, bone injuries, and acute hemorrage regardless of location (ie, parenchymal, subarachnoid, subdural, or epidural spaces). Its limitations include insensitivity in detecting small and predominantly nonhemorragic lesions associated with trauma such as contusion, particularly when adjacent to bony surfaces (ie, frontal lobes adjacent to the orbital roof, anterior temporal lobe adjacent to the greater sphenoid wing, etc). The diffuse axonal injury (DAIs), that result in small focal lesions throughout the cerebral hemispheres, corpus callosum, and upper brainstem and cerebellum, often go undetected on CT in our study as well as cerebral edema. In fact, CT is relatively insensitive for detecting increased intracranial pressure or cerebral edema and for early demonstration of hypoxic-ischemic encephalopathy (HIE) that may accompany moderate or severe head injury. (15)

There are different clinical criteria for children with head injury that are less reliable than those for adults, particularly for children younger than age two, and they must be balanced with the higher risk of radiation exposure in childhood. Noncontrast head CT plays an essential role in the evaluation of children with suspected physical injury.

In our study, and in close agreement with literature data, CT is crucial in recognizing the disease of thorax, which it's the most involved body region in traumatic events. Conventional X-ray (CR) has proven their efficacy in detecting potential life-threatening injuries. The investigation is cheap, non-invasive and it can be repeated at any time and place. However, conventional radiograph is less reliable for the detection of vascular lesions, small pneumothoraxes, pulmonary contusions and lacerations. In fact, pneumothorax occurs in 30-40% of cases and pulmonary contusion is seen in 30-70 % of patients with blunt chest trauma.

Contrast enhanced MSCT is a reliable method also for detecting vascular lesions, especially traumatic dissections of the thoracic aorta. Rupture of the thoracic aorta is a common cause of death following blunt chest trauma. In more than 80% of cases, ruptute is through all three layers of the aorta resulting in exsanguination and death at the accident site. Persons who survive have mantained the adventitia intact but are at risk for subsequent complete rupture. For these near-full-tickness injuries, 30% of initial survivors will die within 6 hours and 20% by 24 hours if the diagnosis in not made and treatment instituted. Injury occurs most commonly at the ligamentum arteriosum (80%) and less to the ascending aorta. (16). Also in our study MSCT recognizes only one vascular lesion of the aorta, at isthmus level, thus confirming that this type of injury, are rarely visible on CT due to the high mortality.(17)

CT has been shown to be a reliable method in diagnosing intra-abdominal injuries. Sensitivity and specificity of MSCT are reported with 95,1% and 99,9% respectively. Comparing ultrasound and CT in patients with abdominal trauma showed that CT revealed additional information in 43% of cases. MSCT is a very effective diagnostic screening method for an accurate identification of hemoperitoneum, retroperitoneal and organ injury and allows an accurate selection of patients who need surgery, transfer to the angiography room or for which a period of close observation is sufficient.

The spleen resulted to be the most involved organ within the abdome. Most often due to blunt trauma, splenic injury is frequently associated with other organ injurie. In the litterature 20% of patients with documentd left rib fractures and 25% of patients with left renal injury also have splenic injury. Of those with splenic laceration, 40% have rib fractures.

Liver injuries can be detected in up to 25% of patients with blunt trauma and like the spleen, is also commonly associated with other intra-abdominal parenchymal injury; 45% of patients with liver injuries have also evidence of splenic trauma. Periportal tracking can sometimes be seen as the only evidence of liver injury but its value of as a CT sign to help guide management of liver trauma remains uncertain and controversial. The right lobe of the liver is more susceptible to laceration because of its larger size and proximity to ribs. (18)

Bowel and omentum injuries are found in approximately 5% of blunt trauma victims at laparotomy and may be diagnosed clinically in less than 1/3 of cases. Traumatic lesions include contusion, hematoma, partial or full laceration of the bowel's wall, and bowel transection. Injuries of the omentum may affect the vascular structures and thus lead to either bleeding or vascular occlusion with subsequent necrosis and eventual perforation of the corresponding bowel structures. In adults, the most frequently involved organs are the jejunum and ileum, less commonly the colon, and occasionally the stomach. In a recent review of the literature, the combination of all of the above-described diagnostic signs yielded a sensitivity of 85-95% for the detection of injuries of the gastrointestinal tract with CT . Although CT enabled detection of omental injuries with high accuracy (96%), the ability to distinguish surgical from nonsurgical omental injuries was poor (sensitivity 37%, specificity 96%).

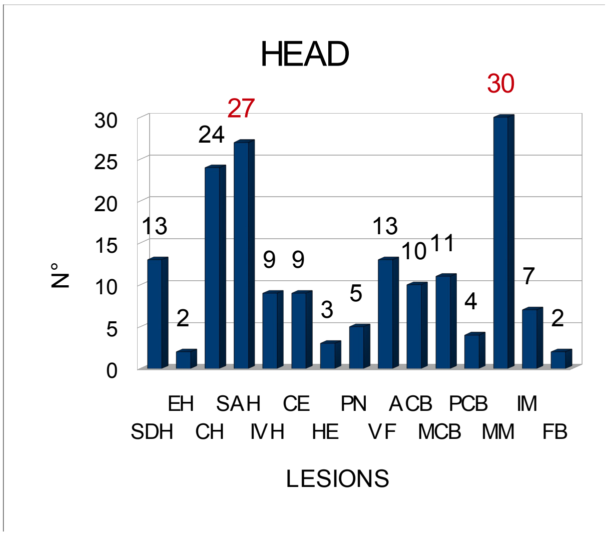
Blunt pancreatic and duodenal trauma is uncommon amounting to less than 2% of all. These injuries often occur during traffic accidents as a result of the direct impact on the upper abdomen of the steering wheel or the handlebars. The duodenum and pancreas can be injured simultaneously (50%–98%), isolated injuries are rare (<30%). Their identification can be difficult because imaging findings are often subtle. Delays in diagnosis, incorrect classification of the injury, or delays in treatment can increase the morbidity and mortality considerably. The morbidity and mortality associated with a trauma to the duodenum and pancreas are remarkably high. Mortality for pancreatic injuries ranges from 9% to 34%; for duodenal injuries it ranges from 6% to 29%. However, only 5% of the pancreatic injuries and 30% of the duodenal injuries are directly related to the fatal outcome. Organ injuries most commonly associated with pancreatic trauma are hepatic (46.8% of cases), gastric (42.3%), major vascular (41.3%), splenic (28.0%), renal (23.4%), and duodenal (19.3%). Most blunt pancreatic injuries (>65%) occur in the pancreatic body; the tail and head are less common.(19)

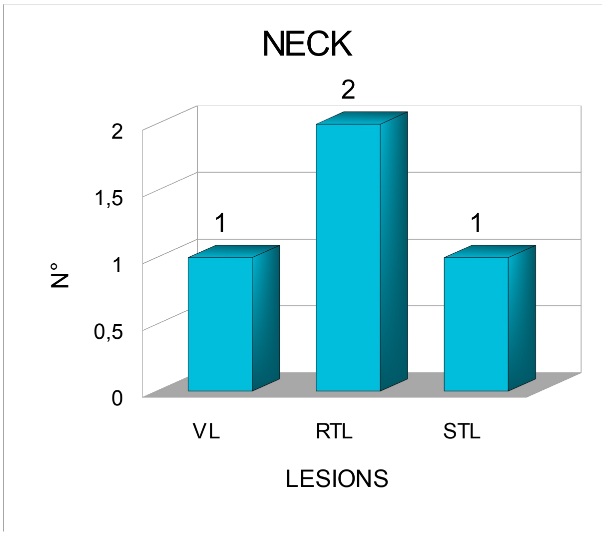
Adrenal injury due to trauma is quite rare because the gland is centrally located within the abdomen and is well cushioned by adjacent soft-tissue structures.

Bladder injuries are usally associated with pelvic fractures, penetrating trauma and compressive-type injuries (these usually occur at bladder dome) and contusion or leakage of the wall.
Traumatic herniations of the diaphragm can result from either blunt or penetrating trauma or forcerful vomiting. Generally, the diagnosis may be suspected only if there is an appropriate history. Approximately 1-8% of patients who survive major blunt injury to the chest or abdomen have traumatic rupture of the diaphragm. Diaphragmatic hernias show a left-to-right predominance of 9:1, probably because of the protective effect of the liver, which prevents the bowel from heriating through. CT cofirm the diagnosis by demostrating the discontinuity of the diapfragmatic ring. (20)
In our study, in close agreement with literature data, we have found a prevalence of involvement of the spleen and liver in blunt abdominal trauma, followed by involvement of the kidney, adrenal gland, and finally we had a single case of pancreatic contusion. In addition, a patient with severe trauma of the pelvis showed tearing of the bladder.There were no injuries to the gastrointestinal hollow organs.
With regard to the child, the liver is the organ most frequently involved in abdominal trauma because of the greater flexibility of the coasts. The spleen is involved in 25-30% of abdominal injuries while the pancreas in 5%, however is the most common cause of pancreatitis (belts, bicycle handlebar) and may be associated with duodenal involvement as an adult. The gastrointestinal tract is affected in 5-10%. (21)
In our experience, we didn't have make a judgment on the incidence of injuries in children because the case studies was poor.
With regard to the involvement of the spine, transverse scans with adequate windowing, completed by sagittal and coronal reconstructions have a sensitivity for fractures of nearly 100%. Cervical spine fractures account 2/3 of all spine fracture especially C3, C5 e C7, in the remaining cases the dorsal and lumbar especially has been involved from D5 to D7 and from D11 to L1. The majory of fractures occur near the thoracolumbar junction.
Our data deviate from the literature because the portion of the spine more interested was the dorsal, followed by cervical and finally the lumbo-sacral. (22)
CT is also very effective in diagnosing pelvic ring and acetabular fractures and it's indispensable because provide more detailed information about fractures of the sacrum or disruptions of the sacroiliac joint as well as about intrapelvic organ lesions.

In conclusion the technical characteristics of CT enable an effective diagnosis and a focused therapy of potentially life-threatening injuries at an early stage of the emergency room treatment, for this reason the MSCT plays a crucial role in the management of polytrauma patients.

Graphic 1 e 2

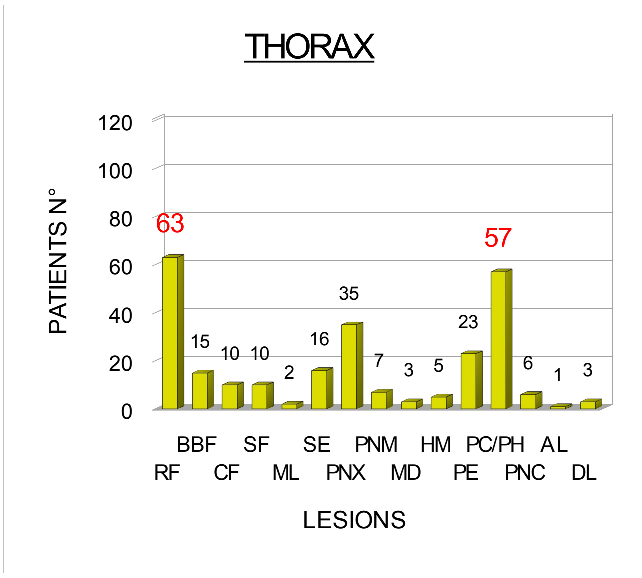




1 - **SDH:** SUBDURAL HEMATOMA **EH**:EXTRADURAL HEMATOMA **CH**:CEREBRAL HAEMORRAGE **SAH**: SUBARACHNOID HAEMORRAGE **IVH**: INTRAVENTRICULAR HAEMORRAGE **CE**:CEREBRAL OEDEMA **HE**: HERNIATION **PN**: PNEUMOENCEPHALUS VF:VAULT FRACTURE **ACB**: FRACTURE OF THE ANTERIOR CRANIC BASE **MCB**: FRACTURE OF THE MIDDLE CRANIC BASE **PCBF:** FRACTURE OF THE POSTERIOR CRANIAL BASE **MMFF**: FRATTURA TERZO MEDIO MASSICCIO FACCIALE **IM**:FRACTURE OF THE INFERIOR PORTION OF THE MAXILLO FACIAL REGION **FB**: FOREIGN BODIES

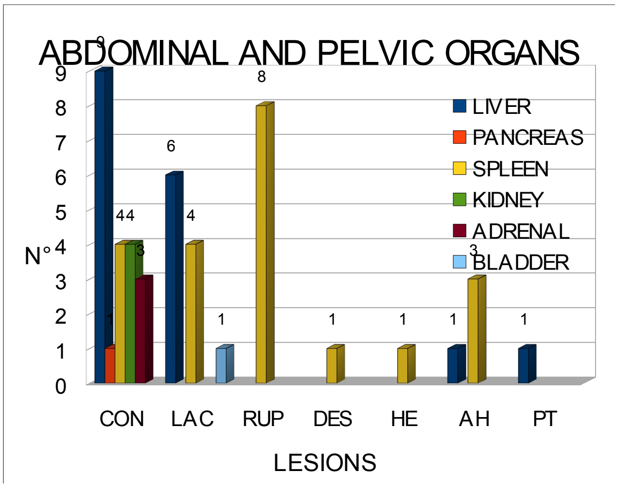
2 - **RTL:** RESPIRATORY TRACT LESION **VL:** VASCULAR LESION **STL:** SOFT TISSUE LESION

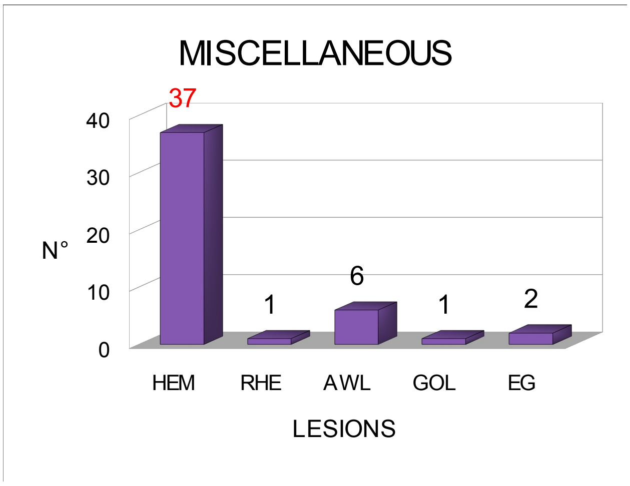
Graphic 3



3 - **RF:** RIBS FRACTUR **BBF**: BREAST BONES FRACT. **CF**: CLAVICOLA FRACT. **SF**: SCAPOLA FRACT. **ML**: MUSCULAR LESION **SE**: SUBCUTANEOUS EMPHISEMA **PNX**: PNEUMOTHORAX **PNM**: PNEUMOMEDIASTINUM **MD**: MEDIASTINUM DELOCALIZATION **HM**: HAEMOMEDIASTINUM **PE**: PLEURAL EFFUSION **C/HP**: PULMONARY CONTUSION/HAEMORRAGE **PNC**: PNEUMOCELE **AL**: AORTIC LESION **DL**: DIAPHRAGMATIC LESION

Graphic 4 e 4b

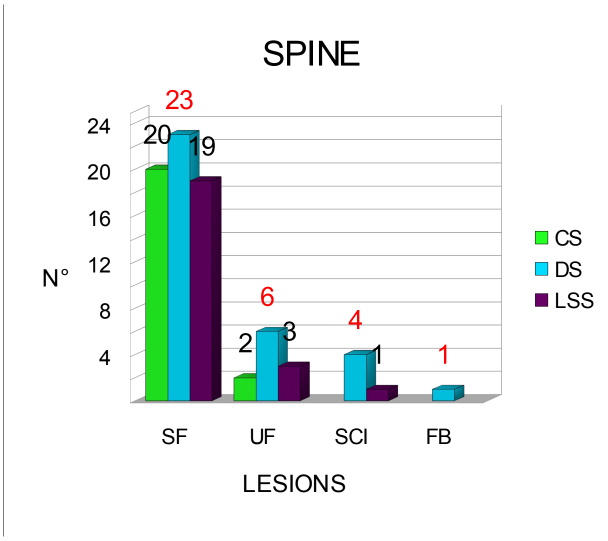




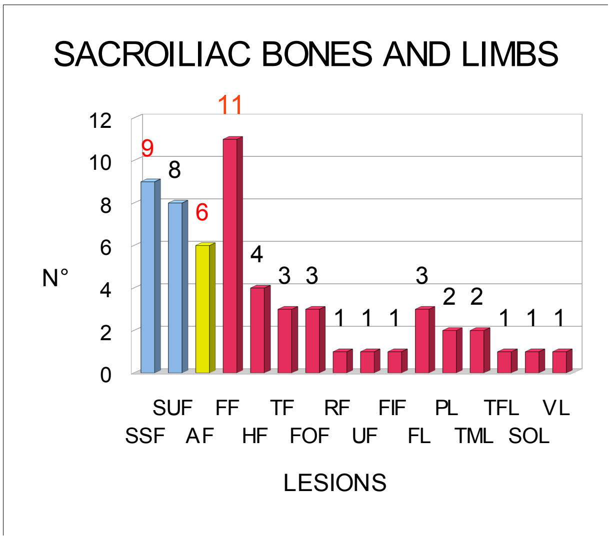
4 - **CON:** CONTUSION **LA: LACERATIONS RUP**: RUPTURES **DES**: DESTRUCTION **HE**: HEMATOMA **AH:** ACTIVE HAEMORRAGES **PT:** PERIPORTAL TRACKING

4 b - **HEM:** HEMOPERITONEUM **RHE**: RETROPERIOTNEAL HEMATOMA **AWL**: ABDOMINAL WALL LESIONS **GOL:** GREAT OMENTUM LACERATION **EG:** EXTERNAL GENITAL LESIONS

Graphic 5



Graphic 6



5 - **SF**: STABLE FRACTURE **UF**: UNSTABLE FRACTURE **ISC**: SPINAL CORD INVOLVEMENT **FB**: FOREIGN BODY (metallic fragment)

6 – **SSF**: SACROILIAC BONE STABLE FRAC. **SUF**: SACROILIAC BONE UNSTABLE FRACTURE. **AF:** ACETABOLAR FRACTURE **FF:** FEMUR FRAC. **HF:** HUMERUS FRAC. **TF:** TIBIA FRAC. **FOF:** FOOT FRAC. **RF:** RADIUS FRAC**. UF:** ULNAR FRAC. **FIF:** FIBULA FRAC. **FL**: FEMUR LUXATIONS **PL**: PATELLA LUX. **TML**: TARSOMETATARSAL LUX. **TFL**: TIBIOFIBULA LUX. **SOL**: SCAPULO HUMERAL LUX. **VL**: VASCULAR LESION

Allegato 1

Percorso diagnostico strumentale del paziente politraumatizzato
Protocollo operativo di interfaccia tra Dipartimento Emergenza Urgenza, Terapia Intensiva ed Area della Diagnostica per immagini

PAZIENTE POLITRAUMATIZZATO

A, B, C, D, E effettuato dal medico di PS
(<u>Valutazione primaria</u>)

Se ABCDE alterati (paziente instabile) collaborazione con il Medico Rianimatore per condivisione del percorso diagnostico-terapeutico

↓

Se grave compromissione respiratoria che necessita di immediata diagnosi e trattamento
RX TORACE
In stanza emergenza durante la Valutazione Primaria

↓

SEMPRE
ECO-FAST
In stanza emergenza durante la Valutazione Primaria

↓

TC **-CRANIO**
-CERVICALE (studio completo)
-TORACE (*)
-ADDOME (*)
-BACINO (*)

<u>SOLO AL TERMINE DELLA VALUTAZIONE PRIMARIA</u>
(*) con mezzo di contrasto, secondo quesito clinico a discrezione del Medico Radiologo

↓

Rivalutazione posizionamento collare cervicale e tavola spinale al termine degli accertamenti radiologici e dopo valutazione specialistica quando indicato

↓

Completamento studio Radiologico nella Radiologia di PS, se necessario, in paziente stabile senza insufficienza grave di uno o più organi o apparati

Tabella 1

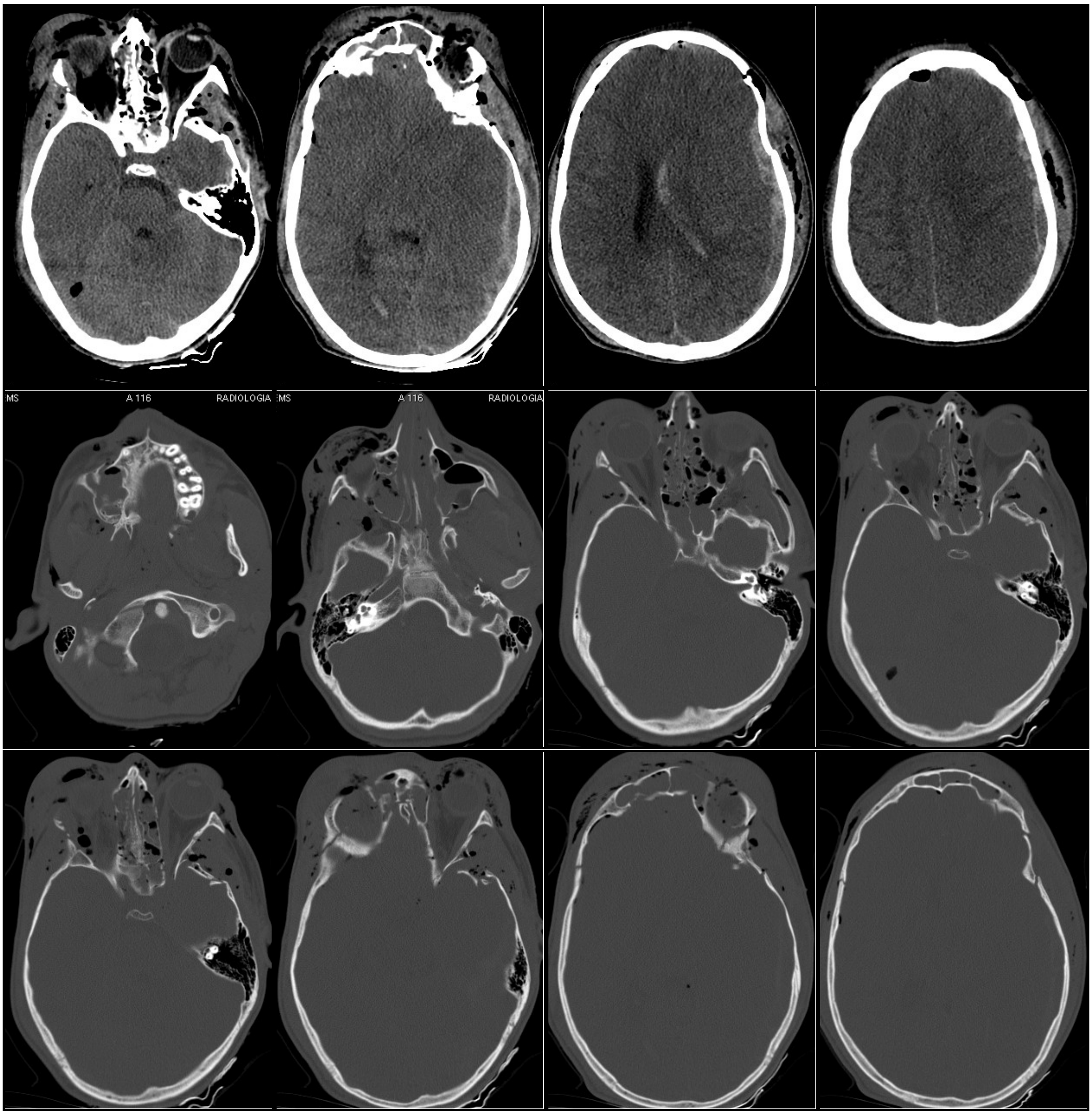
PROTOCOLLI DI STUDIO TC

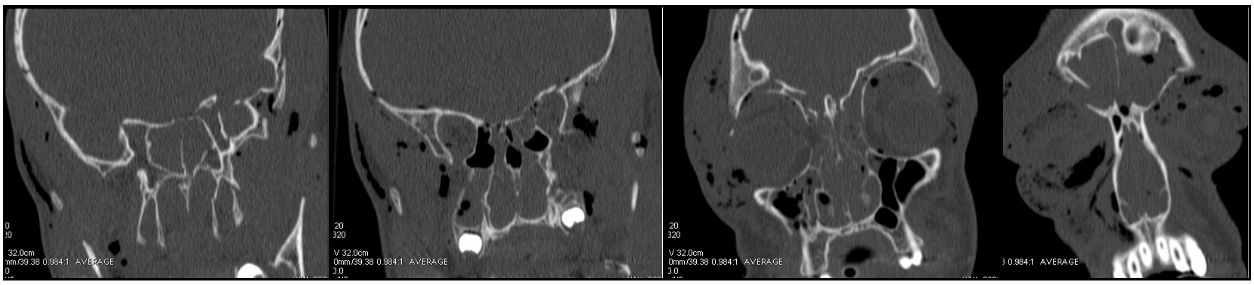
	Slice thickness	Increment	Reconstruction algorithm	Retroricostruzione	Acquisition	ICM	Dose
BRAIN	5 mm	/	Soft tissue	Bone (2,5 mm)	Axial	NO	CTDI 51 mGy DLP 750 mGy.cm
CERVICAL SPINE	1,25 mm	0,625 mm	Bone	Soft tissue (2,5/1,25mm)	Spiral	NO	CTDI 5,95 mGy DLP 127 mGy.cm
NECK	Pre-contrast and Post-contrast* 2,5 mm	1,25 mm	Soft tissue	Bone (1,25/0,625mm)	Spiral	YES	CTDI 17 mGy CTDI 17 mGy DLP 448 mGy.cm
TORAX/ ABDOMEN (Lung apex to ischium/greater trochanter) **VASCULAR CT**	Pre-contrast 5-2,5 mm Post-contrast* 2,5 mm Post-contrast* 0,6 mm	2,5-1,25 mm 1,25 mm 0,4 mm	Soft tissue	Lung (1,25/0,625mm) Bone (1,25/0,625mm)	Spiral	YES	CTDI 20 mGy CTDI 27 mGy CTDI 27 mGy DLP 6044 mGy.cm CTDI 6/12/12 mGy DLP 1146 mGy.cm
SKELETAL REGION	1,25 mm	0,625 mm	Bone		Spiral	NO	2

*The study includes the arterial phase with, circulation time, and venous phase. Possible late stage with endocavitary contrast to clinical judgment.
**The volume used depends on the physical condition and age of the patient (normal-weight adult patient we use 120-130 ml with injection flow 3-5 ml/sec.

IMAGES

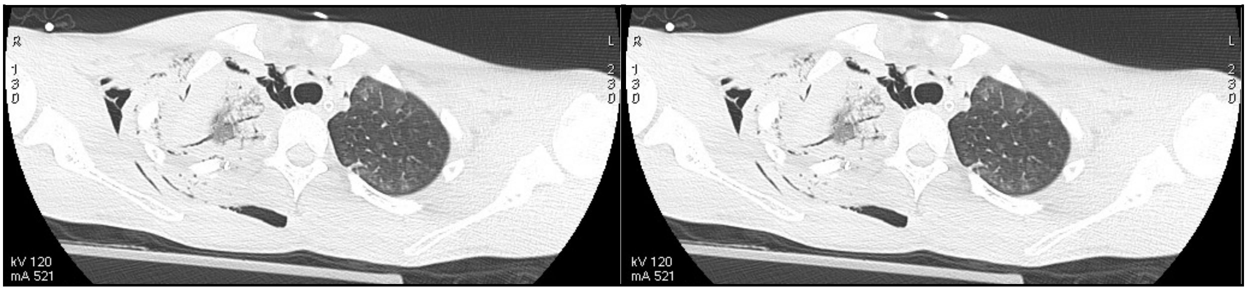
Case 1

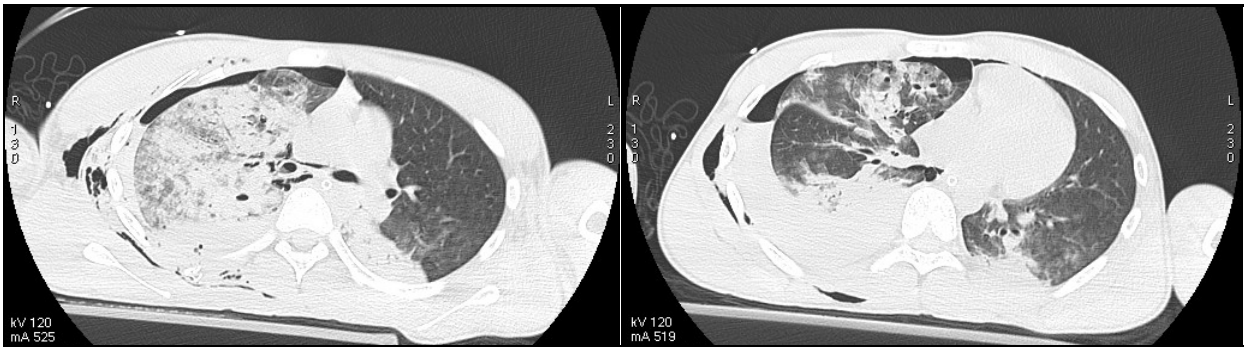


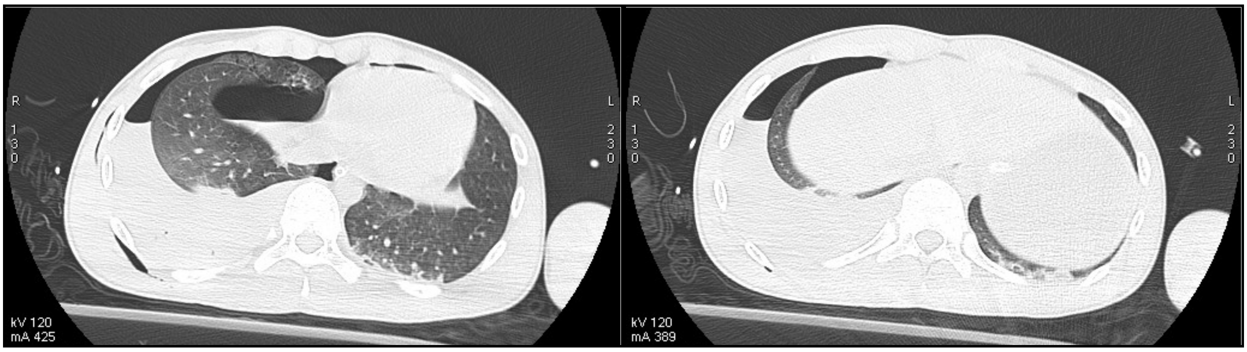


Raccolta sottodurale sinistra, shift verso destra della linea mediana, associato ad edema cerebrale diffuso con ernia subfalciale e transtentoriale. Versamento ematico intraventricolare, diffuse bolle di pneumoencefalo, emorragie puntiformi corticali e cortico-sottocorticali come per DAI. Multiple fratture del massiccio facciale, del neurocranio e della volta cranica con emoseno ed enfisema sottocutaneo.

Case 2

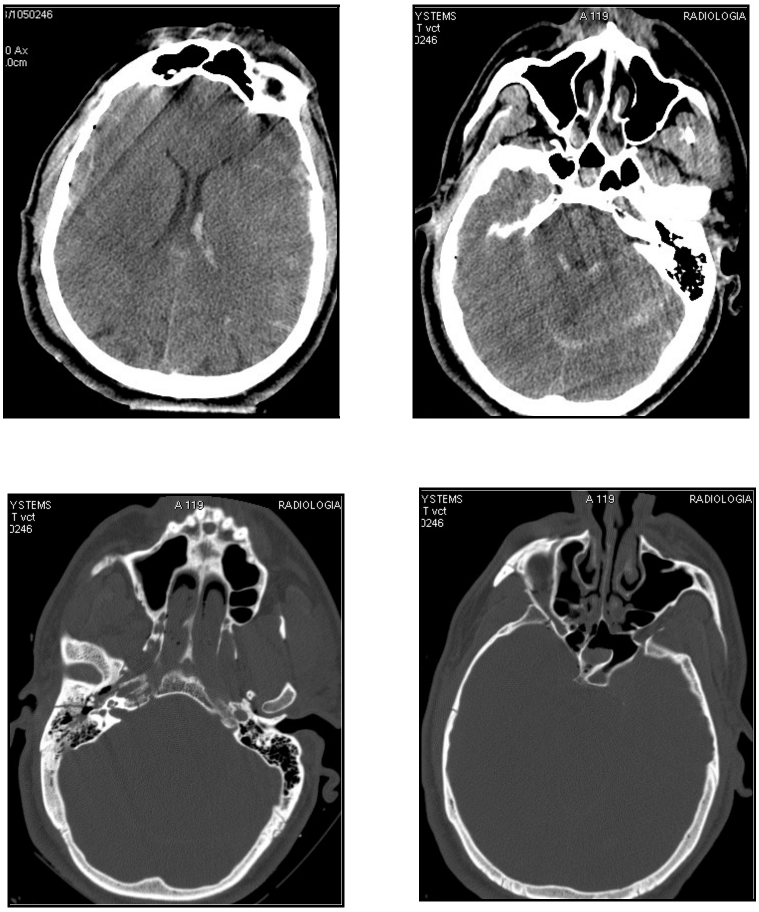




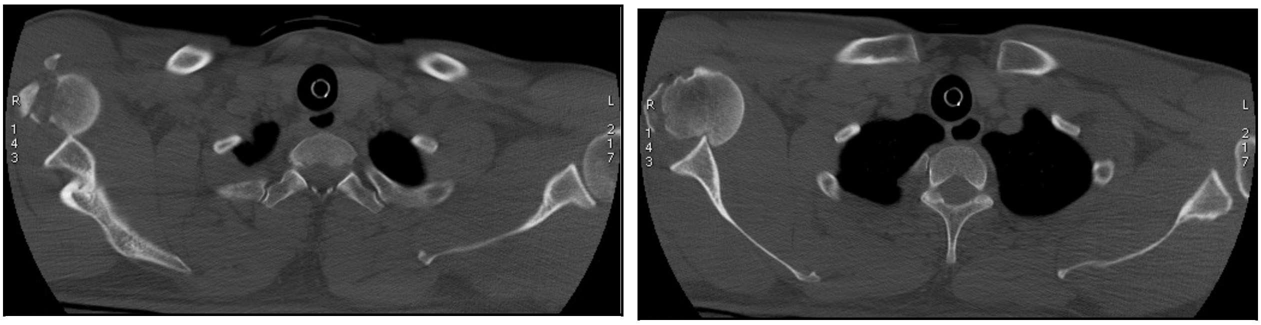


Esteso focolaio contusivo polmonare a destra associato a multipli pneumatoceli, a versamento pleurico, pneumotorace (PNX), pneumomediastino ed enfisema sottocutaneo.Sbandamento verso sinistra dell'asse mediastinico. Piccoli focolai contusivo-emorragici nel polmone sinistro con minimo PNX.

Case 3

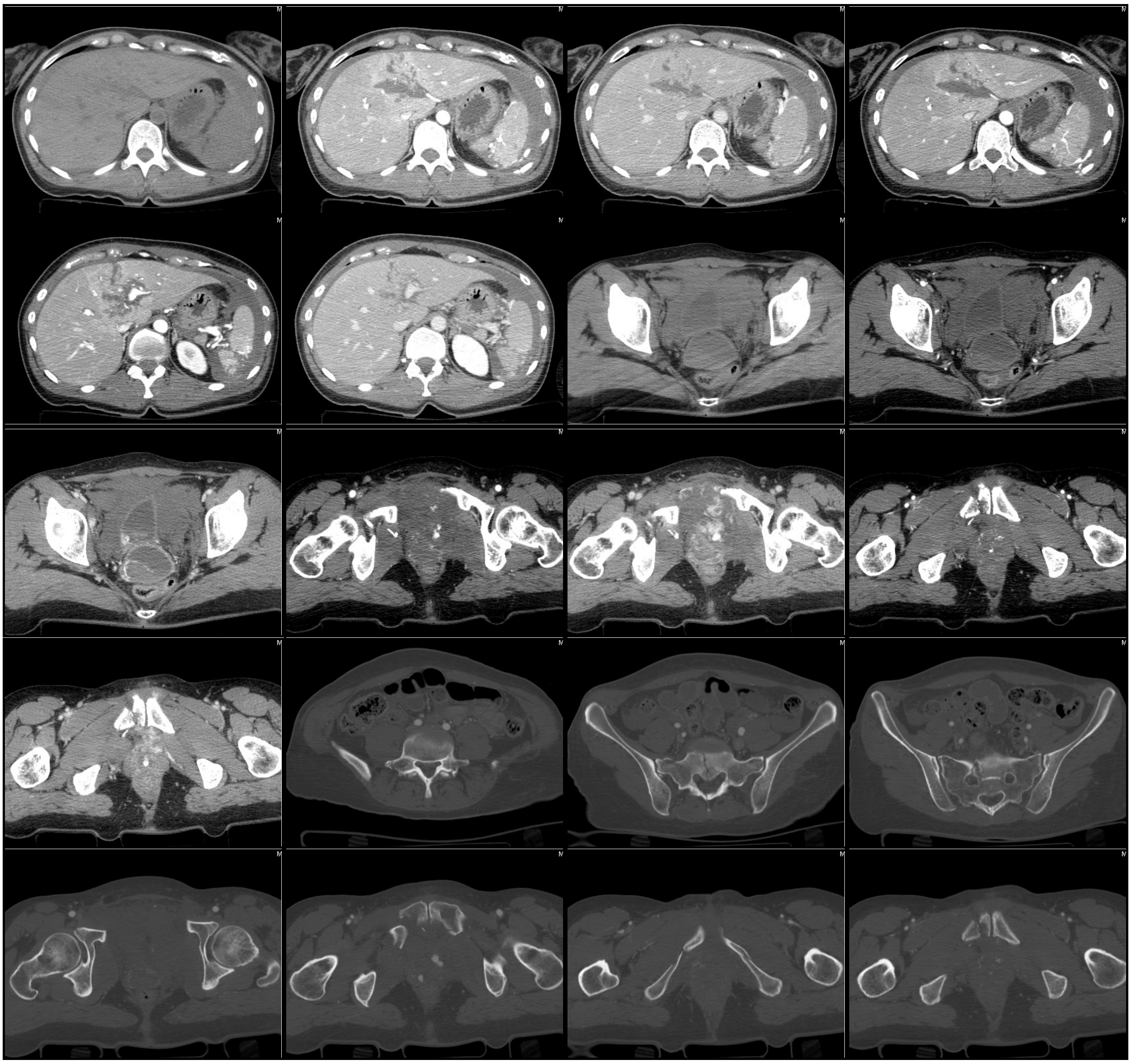


Multipli focolai contusivo-emorragici con aspetto edematoso dell'encefalo ed appiattimento delle circonvoluzioni. Emorragia subaracnoidea (ESA), inondazione ematica ventricolare.
Frattura della rocca petrosa destra con frattura del meato ed emotimpano, multiple fratture del massiccio facciale e del neurocranio.



Frattura della testa dell'omero destro e dell'ala della scapola a livello sovraglenoideo.

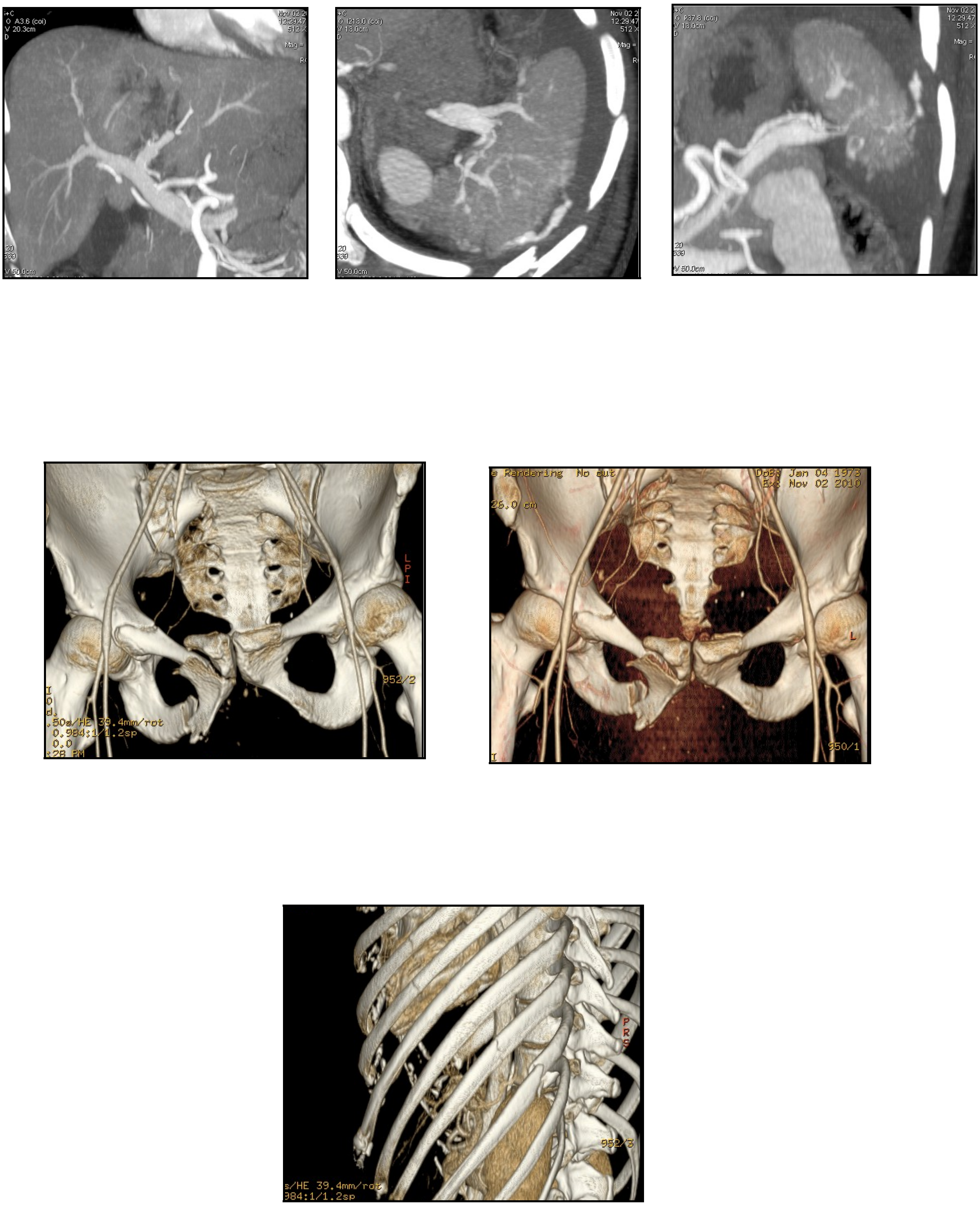
Case 4



Grossolana lesione contusivo-emorragica con lacerazione del IV segmento epatico estesa in parte anche al II ed al I. Frattura completa del polo splenico inferiore con associta lesione del polo superiore e sanguinamento attivo in fase arteriosa. Sanguinamento attivo a livello pelvico con interessamento traumatico dell'utero e dei genitali esterni. Abbondante versamento addomino-pelvico.

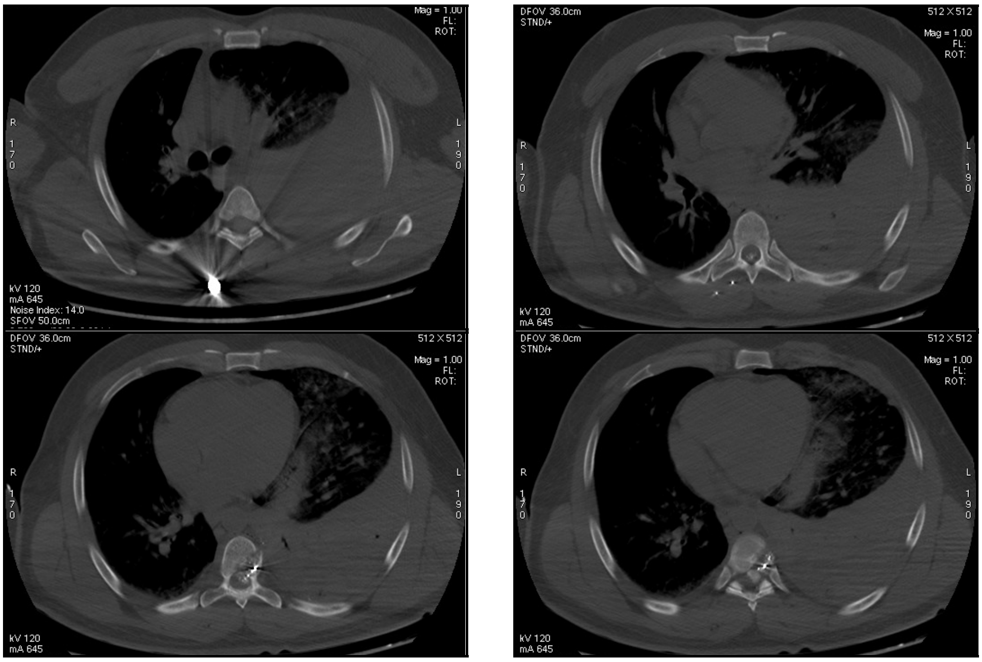
Multiple fratture costali a sinistra.
Frattura scomposta della branca ileo ed ischio pubica bilaterale con frammenti ossei dislocati, frattura completa del sacro a decorso longitudinale paramediano a destra, frattura di entrambe le ali sacrali.

Case 4a (Post processing)



Multiplanar Reconstructions (MPR) and Volume Rendering (VR).

Case 5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190
kV 120
mA 645
Noise Index: 14.0
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DFOV 36.0cm
STND/+
512 X 512
Mag = 1.00
FL:
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kV 120
mA 645
DFOV 36.0cm
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Mag = 1.00
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kV 120
mA 645
DFOV 36.0cm
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170
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kV 120
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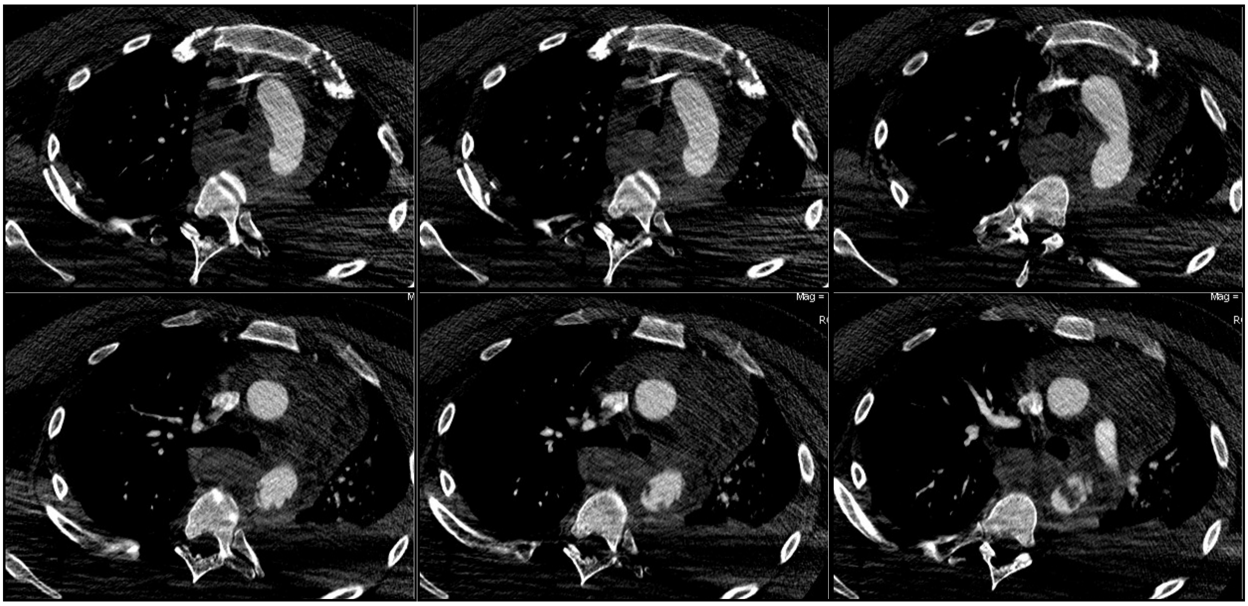
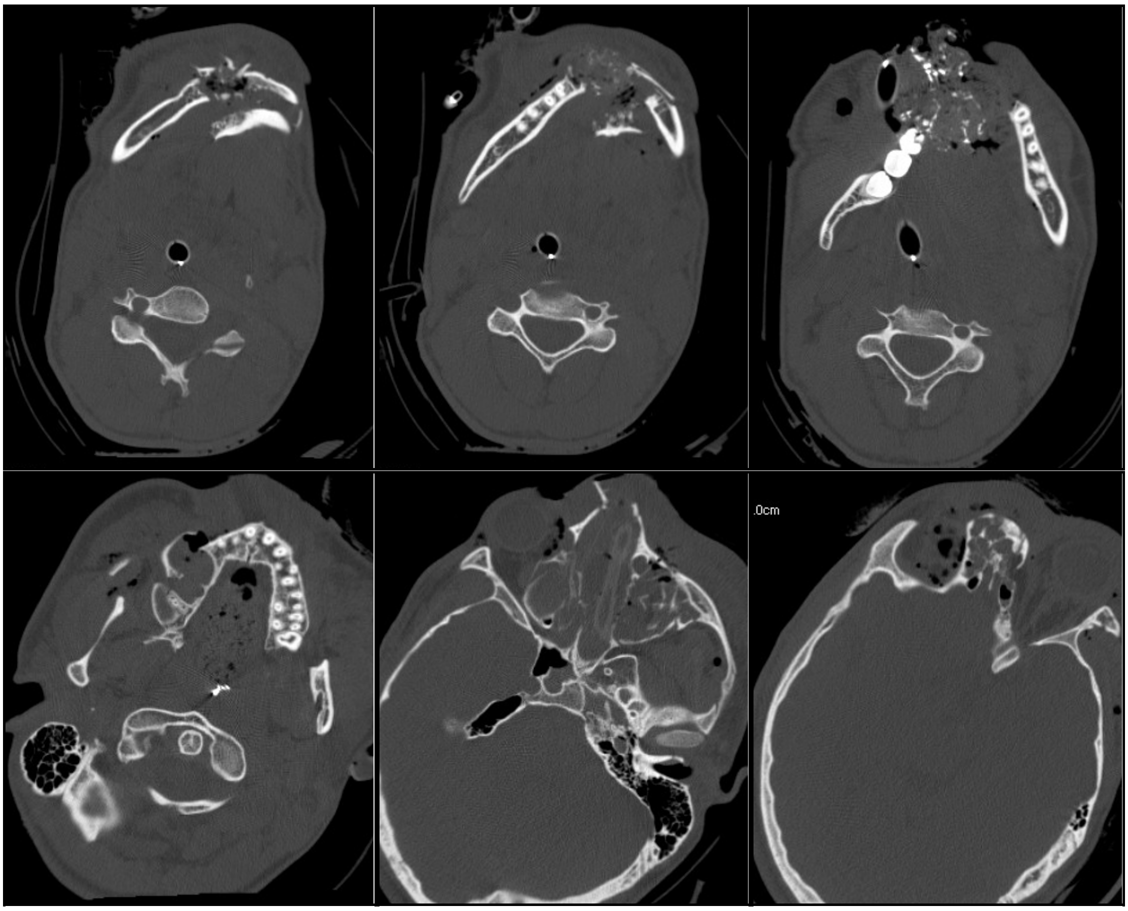
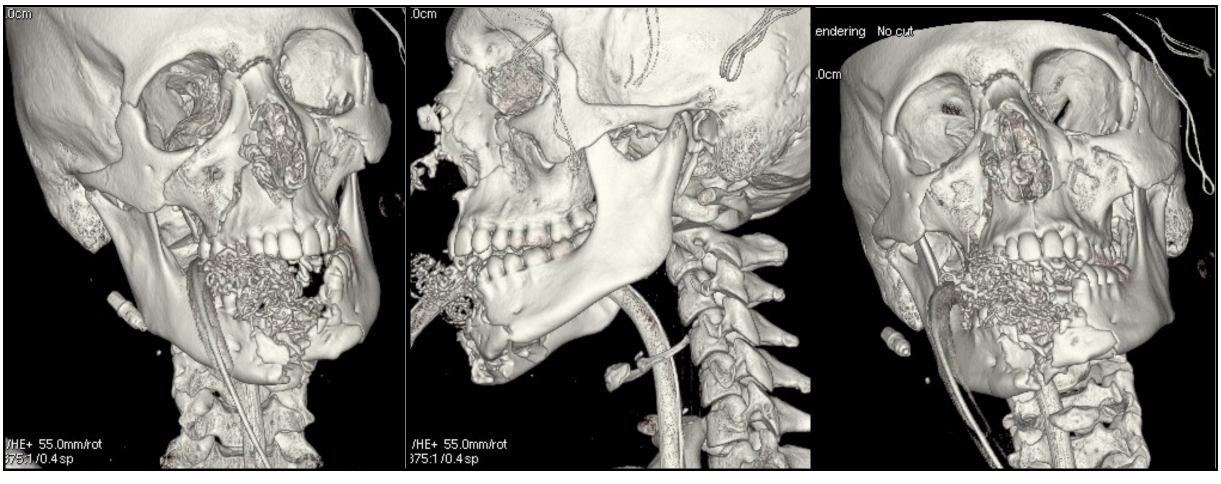
S 250
RADIOLOGIA

Case 6



Case 7

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/HE+ 55.0mm/rot
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/HE+ 55.0mm/rot
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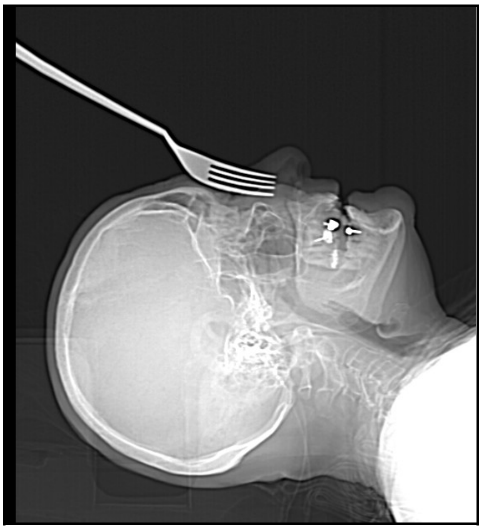
Case 8



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